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# U.S. PATENT APPLICATION
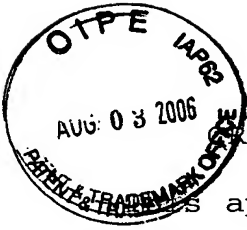
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*Title:*        VEHICULAR ANOMALY DIAGNOSIS SYSTEM

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# *MARKED-UP SPECIFICATION*

# VEHICULAR ANOMALY DIAGNOSIS SYSTEM

## CROSS REFERENCE TO RELATED APPLICATIONS

This application is based on and incorporates herein by reference Japanese Patent Application No. 2002-341080 filed on November 25, 2002.

## FIELD OF THE INVENTION

The present invention relates to a vehicular anomaly diagnosis system for diagnosing a function of beforehand detecting an engine start of a vehicle. Here, the engine start is beforehand detected, for instance, when a door is opened and closed or a driver seats himself on a driver seat. Warming up an engine or components relating to the engine is executed prior to the engine start when the engine start is beforehand detected.

## BACKGROUND OF THE INVENTION

Patent Application Publication of USP-2002/0005178 A1 discloses that a heat accumulating device is provided for executing warming-up of an engine of a vehicle prior to a engine start. The engine start is beforehand detected through opening and closing of a door or manipulation of an ignition key as a preparation operation to the engine start. The engine is then warmed up using the heat accumulating device prior to the engine start. Here, in particular, the engine start is prohibited ~~till~~until the warming-up is completed. The warming-up using the heat accumulating device is thereby securely executed.

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However, failure of a function for detecting the preparation operation to the engine start naturally leads to incapability of detecting the preparation operation. Accordingly, the warming-up of the engine cannot be executed before the engine starts. Reducing emission thereby becomes difficult due to starting of the engine in low temperature.

## SUMMARY OF THE INVENTION

It is an object of the present invention to provide a vehicular anomaly diagnosis system capable of detecting failure of a function for beforehand detecting a start of an engine of a vehicle.

To achieve the above object, an anomaly diagnosis system is provided with the following. Warming-up of one of an engine and a component relating to the engine can be executed. A pre-start state is detected by detecting a preparation operation for a start of the engine. Here, the warming-up is ~~beforehand~~ executed prior to the start of the engine when the pre-start state is detected. Furthermore, anomaly of the pre-start state can be detected. This structure of detecting the anomaly of the pre-start state enables ~~notification to~~ the driver to be notified of the anomaly or ~~output~~ the anomaly to be output into a terminal to be referred to by ~~for maintenance in such as~~ a maintenance shop. Unfavorable situations where the engine or the related components cannot be pre-heated prior to the engine start can be thereby restricted and emission can be also restricted.

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## BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects, features, and advantages of the present invention will become more apparent from the following detailed description made with reference to the accompanying drawings. In the drawings:

FIG. 1 is a diagram showing a schematic overall structure of an embodiment of the present invention;

FIG. 2 is a flowchart diagram explaining processing of beforehand detecting of an engine start;

FIG. 3 is a flowchart diagram explaining processing for a main relay control unit to start an ECU;

FIG. 4 is a flowchart diagram explaining processing of pre-heating a heater of an air/fuel ratio sensor ~~till~~until a driver actually starts an engine;

FIG. 5 is a flowchart diagram explaining seat switch failure detection that is processing of detecting failure when a driver is seated;

FIG. 6 is a flowchart diagram explaining seat switch failure detection that is processing of detecting failure when a driver is not seated; and

FIG. 7 is a flowchart diagram explaining processing of stopping an ECU.


## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 shows a schematic overall structure of an engine control unit (ECU) 1 according to an embodiment of the present invention.

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In this embodiment, the ECU 1 receives~~, as information of an~~ ~~engine of a vehicle (not shown),~~ signals ~~of~~<u>indicating</u> cooling water temperature~~29~~, air/fuel ratio~~30~~, and the like~~21 to 28~~<u> of an engine of a vehicle</u>, via a main relay control unit 11 that is to be described. Based on the received plural signals, the ECU 1 executes engine control by outputting, into plural actuators (not shown), signals for controlling the engine.<u> The signals indicating (1)a vehicle speed,(2)an engine rotation speed, (3)an amount of air that is sucked into the engine,(4)a pressure  detected by a suction pressure sensor provided in an exhaust path,(5) an opening degree of an accelerator, (6)an opening degree of a throttle,(7)a deceleration,(8)a depression of stepping of a clutch pedal,(9) a cooling water temperature, and (10) an air/fuel ratio are generated from corresponding signal generators 21, 22, 23, 24, 25, 26, 27, 28, 29, and 30, respectively.</u>-

When an air/fuel ratio sensor (not shown) remains ~~in~~<u>at</u> a low temperature at <u>the time</u> engine <u>is</u> started, feedback control cannot be executed even after the engine start.  The engine control cannot be ~~thereby~~ executed based on an air/fuel ratio, so that restricting emission becomes difficult.  Therefore, the engine start is beforehand detected based on opening/closing of a door or sitting down on a driver seat.  From then, warming-up is beforehand executed ~~with~~ using a <u>sensor  heater  10</u> of an air/fuel ratio sensor— ~~till~~<u>until</u> a driver actually starts the engine.  This leads to enhancing an activated state of the air/fuel ratio sensor prior to the engine start in comparison with a case where the engine is started in low temperature.  The feedback control is thereby quickly executed, so that the

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emission can be restricted.

The ECU 1 is equipped with the main relay control unit 11 for controlling a main relay 3. The main relay control unit 11 detects, through switches 4 to 9 or based on the signals 21 to 30, preparation operations ~~(to engine start)~~ that indicate that the engine is about to be started. When ~~the~~a preparation operation is detected, the ECU 1 ~~is started to~~ controls the ~~air/fuel ratio~~ sensor heater 10 for ~~executing the~~ warming-up ~~of the air/fuel sensor~~the engine ~~till~~until the engine starts.

The switches 4 to 9 shown in FIG. 1 are as follows: an ignition switch 4 that is switched among OFF, ON, and START positions when a driver turns a key; an ignition key insertion switch 5 that is ~~turned into~~switched to an ON state when the driver inserts the key; a door-lock drive switch 6 that is ~~turned into~~switched to an ON state when a door-lock of the vehicle is driven; a ~~door-knob~~door-handle manipulation switch 7 that is ~~turned into~~switched to an ON state when a ~~door-knob~~door-handle is opened; a door opening/closing switch 8 that is ~~turned into~~switched to an ON state when a door is opened; and a seat switch 9 that is ~~turned into~~switched to an ON state when a driver is seated on a driver seat.

In ~~a~~the case where a detection function ~~of preparation operation that detects the preparation operation~~ fails, the warming-up of the ~~air/fuel ratio~~ sensor heater 10 is started only when the driver turns the key for the ignition switch to ~~be switched into~~the START position. ~~Namely, the~~The air/fuel ratio sensor is not pre-heated, so ~~that~~the feedback control is not

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started for a while and restricting the emission thereby becomes difficult. Accordingly, an object of the embodiment is to quickly detect the failure of the detection function of preparation operation to engine start.

Processing relating to detecting the failure of the detection function will be explained below with reference to FIGs. 2 to 7.

FIG. 2 shows processing of beforehand detecting of an engine start or of detecting a preparation operation. At ~~Step~~ Step S100, it is determined whether a state of being not seated shifts into a state of being seated based on a state of the seat switch 9. Here, the state of being not seated is a state where no driver is seated on the driver seat, while the state of being seated is a state where a driver is seated on the driver seat. When the state of being not seated is determined to not shift, the routine is terminated, ~~with~~ bypassing ~~Step~~ Step S101. Otherwise, when the state of being not seated is determined to shift, the processing proceeds to ~~Step~~ Step S101. Here, since it is assumed that a preparation ~~operation to engine start~~ is detected, a pre-heat trigger ~~is outputted as a~~ signal indicating the start ~~for~~ of heating of an air/fuel ratio sensor (pre-heating) is output. The routine is then terminated.

The above-mentioned processing is executed through hardware structure when the seat switch 9 is ~~turned into~~ switched to an ON state. Namely, when the seat switch 9 is ~~turned into~~ switched to an ON state, a battery 2 and the main relay control unit 11 are electrically connected with each other.

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Electric power ~~of~~from the battery 2 is then supplied to the main relay control unit 11. The main relay control unit 11 ~~thereby~~then determines that the pre-heating trigger signal is inputted.

~~In the next place,~~ Next, the processing executed by ~~that~~ the main relay control unit 11 ~~executes~~ for starting the ECU 1 will be explained with reference to FIG. 3. At ~~Step~~ Step S110, it is determined whether the pre-heat trigger is inputted. When the pre-heat trigger signal is not inputted, the processing proceeds to ~~Step~~ Step S111 where it is determined whether ~~an~~the ignition switch 4 is in an ON position. When the ignition switch 4 is not in the ON position, the routine is terminated. Otherwise, when the ignition switch 4 is in the ON position, the processing proceeds to ~~Step~~ Step S112, where the main relay control unit 11 starts the main relay 3. The ECU 1 is thereby started at ~~Step~~ Step S113.

When the ECU 1 is started, the ~~air/fuel ratio~~ sensor heater 10 is pre-heated by a driver ~~for a period till~~until the engine is actually started. The ~~A starter is to be started for starting the~~ engine is started based on ~~according to a~~the state of pre-heating.

Processing ~~of~~performed by the ECU 1 will be explained with reference to FIG. 4. When the ECU 1 is started, pre-heating of the ~~air/fuel ratio~~ sensor heater 10 starts at ~~Step~~ Step S120. At ~~Step~~ Step S121, it is then determined whether the ignition switch 4 is set in START position. When the ignition switch 4 is set in the START position, the processing proceeds to ~~Step~~ Step

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S122. Here, it is determined whether a necessary period for heating the air/fuel ratio sensor has elapsed~~s~~ after the pre-heating starts. When the necessary period has ~~does~~ not elapsed, the processing returns to ~~Step~~ Step S121 and the above-mentioned processing is repeated.

When the necessary period has elapse~~s~~d, the processing proceeds to ~~Step~~ Step S123. Here, a starter (not shown) is compulsorily started to start the engine and the routine is then terminated.

By contrast, when the ignition switch 4 is not in the START position, the processing proceeds to ~~Step~~ Step S124. Here, it is determined whether a given period has elapsed~~s~~ after the pre-heating starts. The given period is set as being longer than the above necessary period. For instance, it can be set by considering consumption of the power of the battery 2 in a case where the engine is not actually started for a while.

When the given period ~~does~~has not elapsed, the processing returns to ~~Step~~ Step S121 and the above processing is repeated. Otherwise, when the given period has elapsed~~s~~, the processing proceeds to ~~Step~~ Step S125. Here, the power supply to the ~~air/fuel ratio~~ sensor heater 10 is stopped to stop the pre-heating, and the routine is then terminated.

As explained above, in this routine, as the ECU 1 is started, the pre-heating is started. Even when the ignition switch 4 is in the START position, the engine ~~start is awaited~~does not start ~~till~~until the pre-heating is completed. When the pre-heating is completed, the engine is started. The

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air/fuel ratio sensor is thereby properly activated at the engine start, so that emission at the engine start can be restricted due to the feedback control. By contrast, when the ignition switch 4 is not in the START position, the pre-heating is started just after starting the ECU 1. However, ~~when the pre-heating is completed and nevertheless the engine is yet to be started,~~ the pre-heating is stopped after the given period, even if the engine is not yet started. The over-consumption of the power of battery 2 can be thereby restricted.

~~In the next place~~Next, ~~a feature of this embodiment will be explained with reference to FIG. 5. In detail, it is~~ the processing ~~of~~for diagnosing a failure of a function for beforehand detecting engine start will be explained with reference to FIG. 5. This routine shows failure diagnosis of the seat switch 9 while a driver is seated on a seat. A state where a driver is not seated on a seat even when a vehicle travels determines that the seat switch 9 fails.

At ~~Step~~Step S130, it is determined whether a period for which a vehicle speed ~~21~~(shown in FIG. 1) exceeds a given speed is greater than or equal to ~~equal to~~a given period ~~or above~~. The given speed can be ~~a~~any positive speed ~~at which a vehicle does not stop~~. When the period is less than the given period, the routine is terminated.

By contrast, when the period is ~~not less than~~greater than or equal to the given period, the vehicle is determined to be traveling. The processing proceeds to ~~Step~~Step S131, where it is determined whether a driver is seated on a seat. When the

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driver is determined to be seated, the processing then proceeds to ~~Step~~ Step S133. Here, since the driver is seated while the vehicle is traveling, it (a diagnosis) is determined to be normal and the routine is then terminated. Otherwise, when ~~the~~no driver is determined to be ~~not~~ seated, the processing proceeds to ~~Step~~ Step S132. Here, it (a diagnosis) is determined to be abnormal and the routine is then terminated.

~~In the next place~~Next, failure diagnosis while a driver is not seated ~~on a seat~~ will be explained with reference to FIG. 6. In this diagnosis, the seat switch 9 is determined to have failed when the seat switch 9 indicates the presence of the driver on the seat even after the driver retires from the vehicle.

At ~~Step~~ Step S150, it is determined whether the ignition switch 4 is in an OFF position. ~~While it~~If~~When~~ the ignition switch 4 is not in the OFF position, the processing at ~~Step~~ Step S150 is repeated. When it is in the OFF position, the processing proceeds to ~~Step~~ Step S151.

At ~~Step~~ Step S151, it is determined whether the ignition key is drawn off from (i.e., drawn out from) an ignition insertion switch 5. When the ignition key is not drawn off, the processing at ~~Step~~ Step S151 is repeated. When the ignition key is drawn off, the processing proceeds to ~~Step~~ Step S152.

At ~~Step~~ Step S152, it is determined ~~through~~via the door opening/closing switch 8 whether a door is opened and closed. When the door is ~~not~~neither opened nor closed, the processing at ~~Step~~ Step S152 is repeated. When the door is opened and closed,

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the processing proceeds to ~~Step~~ Step S153.

At ~~Step~~ Step S153, it is determined through the door-lock drive switch 6 whether a door ~~lock~~ is locked~~executed~~ from an outside of the vehicle. When ~~the~~no door~~lock~~ is ~~not~~ locked~~executed~~ from the outside, the processing at ~~Step~~ Step S153 is repeated. When the door~~lock~~ is locked~~executed~~ from the outside, the processing proceeds to ~~Step~~ Step S154.

In the processing from ~~Step~~ Steps S150 ~~till Step~~ S154, ~~usual~~normal operations that a driver executes, ~~from~~ such as stopping an engine ~~to~~or retiring from the vehicle, are determined. In particular, when the door~~lock~~ is determined to be ~~executed~~locked from the outside of the vehicle at ~~Step~~ Step S153, the driver is ~~never~~presumed not to be seated on the seat. Accordingly, at ~~Step~~ Step S154, it is determined via~~through~~ the seat switch 9 whether the driver is seated on the seat. When the driver is determined not to be ~~not~~ seated, the seat switch 9 is determined to be normal at ~~Step~~ Step S155 and the routine is then terminated. When the driver is determined to be seated, the seat switch 9 is determined to be abnormal at ~~Step~~ Step S156 and the routine is then terminated.

In the above-mentioned routine, the failure diagnosis is conducted on the seat switch 9 after the driver stops the engine. The ECU 1 ~~is~~ therefore need~~s~~ed to be running even when the driver stops the engine. Processing from the time ~~stopping of~~ the engine is stopped by the driver until ~~to stopping of~~ the ECU 1 is stopped will be explained with reference to FIG. 7.

When at ~~Step~~ Step S140 the ignition switch 4 is

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affirmatively determined to be in ~~an~~the OFF position, the processing proceeds to ~~Step~~ Step S141. Otherwise, ~~the processing at Step~~ Step S140 is repeated. At ~~Step~~ Step S141, it is determined whether the failure diagnosis of the seat switch 9 explained in FIG. 6 is completed. When the failure diagnosis is completed, the processing proceeds to ~~Step~~ Step S143. Here, the ECU 1 is stopped and the routine is then terminated.

By contrast, if the failure diagnosis is not completed, the processing proceeds to ~~Step~~ Step S142. Here, it is determined whether a given period has elapsed~~s~~ after the failure diagnosis started~~s~~. The given period is set for preventing over-consumption of the power of battery 2 even in an abnormal case where the failure diagnosis continues to be conducted without ~~a stop~~the ECU 1 stopping.

When the given period has ~~does~~ not elapsed, ~~the processing at Step~~ Step S142 is repeated until ~~for awaiting the~~ completion of the failure diagnosis. Otherwise, when the given period has elapsed~~s~~, the processing proceeds to ~~Step~~ Step S143. Here, the ECU 1 is ~~compulsorily~~ stopped in order ~~for~~ to prevent~~ing~~ the over-consumption of the power of battery 2 and the routine is then terminated.

As explained above, in this embodiment, the preparation operation before the~~to~~ engine is started is ~~predicted~~detected based on the position of the seat switch 9. Here, in ~~a~~the case where the seat switch 9 is ~~by failure~~ fixed in an ON or OFF state due to a failure, it is not detected whether a driver is seated on a seat. ~~The failure of the seat switch 9 is required~~

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to be notified to the driver by |the| failure diagnosis of the seat switch 9. The failure diagnosis of the seat switch 9 can notify the driver of the failure of the seat switch 9. As a result, since replacement of the component ~~relating to~~causing the failure of the seat switch 9 can be completed, ~~so that no prediction of~~ the engine start can be predicted~~avoided~~. The engine is ~~not~~ thereby prevented from starting~~ed~~ in a condition where the air/fuel ratio sensor is not heated. This results in ~~restricting deteriorating~~ restriction of the emission.

(Modification 1)

In the above embodiment, whether a driver operates a vehicle is determined by whether a vehicle speed ~~21~~ exceeds a given speed ~~at Step 130 in FIG. 5~~. Anomaly of the seat switch is determined when the seat switch indicates that no driver is seated even while the driver is operating the vehicle. In this embodiment, whether a driver operates a vehicle is determined by one of the following conditions: ~~a condition is that~~whether an engine rotation speed ~~22~~ that is detected by a clunk sensor or the like is greater than or equal to a given speed ~~or above~~; ~~a condition is that~~whether an amount ~~23~~ of air that is sucked into the engine is greater than or equal to a given amount ~~or above~~; ~~a condition is that~~whether a pressure ~~24~~ detected by a suction pressure sensor provided in an exhaust path is greater than or equal to a given pressure ~~or above~~; ~~a condition is that~~whether an opening degree ~~25~~ of an accelerator operated by a driver is greater than or equal to a given degree ~~or above~~; ~~a condition is that~~whether an opening degree ~~26~~ of a throttle is greater than

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or equal to a given degree ~~or above~~; ~~a condition is that~~whether a deceleration~~an amount 27 of stepping of a brake pedal~~ is greater than or equal to a given amount ~~or above~~; and ~~a condition is that~~whether a depression of~~an amount 28 of stepping of~~ a clutch pedal is greater than or equal to a given amount ~~or above~~. ~~(The parameters 22 to 28 used in the conditions are shown in FIG. 1.)~~ The above conditions can be used individually or in combination~~for determining by using each of the conditions or by using a combination of plural conditions~~.

(Modification 2)

In the above embodiment, an anomaly of the seat switch 9 is determined when the seat switch 9 indicates that no driver is seated while the driver operates the vehicle. However, in ~~a~~the case where the seat switch 9 ~~may~~ malfunctions due to electric noise while the driver operates the vehicle, it is mistakenly determined that no driver is seated on a seat. Therefore, in this embodiment, when an abnormal state continues for a given period, the anomaly of the seat switch 9 is finally determined. This restricts mistaken~~ly~~ diagnosis~~ing~~ of the anomaly even when the electric noise affects the seat switch 9.

The anomaly of the seat switch 9 can be also finally determined when an anomaly counter exceeds a given count. Here, the anomaly counter is continuously incremented while the anomaly is being detected.

(Modification 3)

In the above embodiment, an ON or OFF state of the seat switch 9 is used for detecting a preparation operation and an

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anomaly of the seat switch 9 is determined by comparing a state of the seat switch 9 with a state where ~~a~~the vehicle is operated.

In this embodiment, a preparation operation is detected based on whether an ignition key is inserted. ~~By contrast, the~~ The vehicle is determined to be ~~in~~being operated operation when the ignition key is in the~~an~~ ON position or START position. ~~Namely,~~ Whether or not an ignition key is inserted is determined using an ignition key insertion switch 5. ~~when~~When ~~an~~the ignition key ~~insertion switch 5 is in the~~an ON state~~is determined to be inserted while~~and an the ignition key ~~5~~is in ~~an~~the ON position or in the~~a~~ START position, ~~the ignition key insertion switch is normal. In this case, A~~a function of detecting a preparation operation to engine start is ~~thereby determined to be~~ normal. By contrast, when ~~an~~the ignition key ~~insertion switch 5 is in an ON state~~is determined not to be inserted ~~and an~~while the ignition key is ~~neither~~in ~~an~~the ON position ~~nor~~or in ~~a~~the START position, ~~the ignition key insertion switch 5 is abnormal. In this case, a~~A function of detecting a preparation operation to engine start is ~~thereby determined to be~~ abnormal.

~~As explained above, failure diagnosis can be also conducted on a function of detecting a preparation operation based on the ignition key insertion switch 5.~~

In this embodiment, whether a vehicle is ~~being operated~~in operation can be also detected based on one of the following conditions: ~~a condition is that~~whether a vehicle speed

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~~21~~ is greater than or equal to a given speed ~~or above~~; a ~~condition is that~~whether an engine rotation speed ~~22~~ that is detected by a clunk sensor or the like is greater than or equal to a given speed ~~or above~~; ~~a condition is that~~whether an amount ~~23~~ of air that is sucked into the engine is greater than or equal to a given amount ~~or above~~; ~~a condition is that~~whether a pressure ~~24~~ detected by a suction pressure sensor provided in an exhaust path is greater than or equal to a given pressure ~~or above~~; ~~a condition is that~~whether an opening degree ~~25~~ of an accelerator operated by a driver is greater than or equal to a given degree ~~or above~~; ~~a condition is that~~whether an opening degree ~~26~~ of a throttle is greater than or equal to a given degree ~~or above~~; ~~a condition is that~~whether ~~an amount 27 of stepping of a brake pedal~~ a deceleration is greater than or equal to a given amount ~~or above~~; and ~~a condition is that~~whether a depression of ~~an amount 28 of stepping of~~ a clutch pedal is greater than or equal to a given amount ~~or above~~.

(Modification 4)

In the preceding embodiment, a preparation operation is detected based on whether an ignition key is inserted. However, in this embodiment, a preparation operation is detected based on an ON/OFF signal of a door opening/closing switch 8. Here, when a driver retires from a vehicle by opening and closing a door, a ~~door knob~~door-handle is also manipulated. Accordingly, in this embodiment, whether a door is actually opened and closed is determined based on ~~an~~ ON and OFF signals of the ~~door knob~~door-handle manipulation switch 7. Therefore, an anomaly of the door

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opening/closing switch 8 is determined when the ON/OFF signals of the door opening/closing switch 8 are not detected for a period including time when the ON and OFF signals of the ~~door knob~~door-handle manipulation switch 7 are detected. ~~An~~ ~~a~~Anomaly of a function of detecting a preparation operation to engine start can be thereby detected.

By contrast, the status of the door-handle manipulation switch 7 can be used instead of the door opening/closing switch 8 ~~as a target of a preparation operation can be substituted by the door knob manipulation switch 7~~. ~~Namely, a~~ A preparation operation to engine start is detected based on an ON/OFF signal of a ~~door knob~~door-handle manipulation switch 7. ~~Anomaly~~ An anomaly of the ~~door knob~~door-handle manipulation switch 7 is determined when the ON/OFF signals of the ~~door knob~~door-handle manipulation switch 7 are not detected for a period including time when the ON and OFF signals of the door opening/closing switch 8 are detected.

(Modification 5)

In the above embodiments, failure diagnosis is conducted based on a function of a preparation operation to engine start. In addition to that, when the anomaly is detected, a history of the anomaly can be stored in a backup RAM within the ECU 1.

(Modification 6)

In the above embodiments, the processing of failure detection is executed as shown in FIGs. 5 and~~,~~ 6. ~~However, in~~In this embodiment, the processing of the failure diagnosis can be ~~repeatedly~~ continued without interruption ~~till~~until the failure

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diagnosis is eventually completed. Furthermore, when the failure diagnosis cannot be completed after a given period, the failure diagnosis can be compulsorily interrupted.

(Modification 7)

In the above embodiments, ~~an air/fuel ratio~~the sensor heater 10 provided in the~~an~~ air/fuel ratio sensor is pre-heated. However, when a suction pipe heater 31 is provided for heating a suction pipe, warming-up can be executed by controlling an electric current flowing through the suction pipe heater 31. Furthermore, a heater 32, 33, 34 can be provided in at least one of the following: a ~~catalyst~~ catalytic converter provided in the exhaust gas path for purifying harmful gas; a fuel injection valve provided for injecting fuel into the engine; and a canister provided for adsorbing vapor fuel vaporized from a fuel tank. The above heaters 31 to 34 are shown in FIG. 1.

Furthermore, each of the above-mentioned embodiments can be ~~also~~ used in~~as~~ ~~a~~ combination with another embodiment ~~within the embodiments~~.

It will be obvious to those skilled in the art that various changes may be made in the above-described embodiments of the present invention. However, the scope of the present invention should be determined by the following claims.